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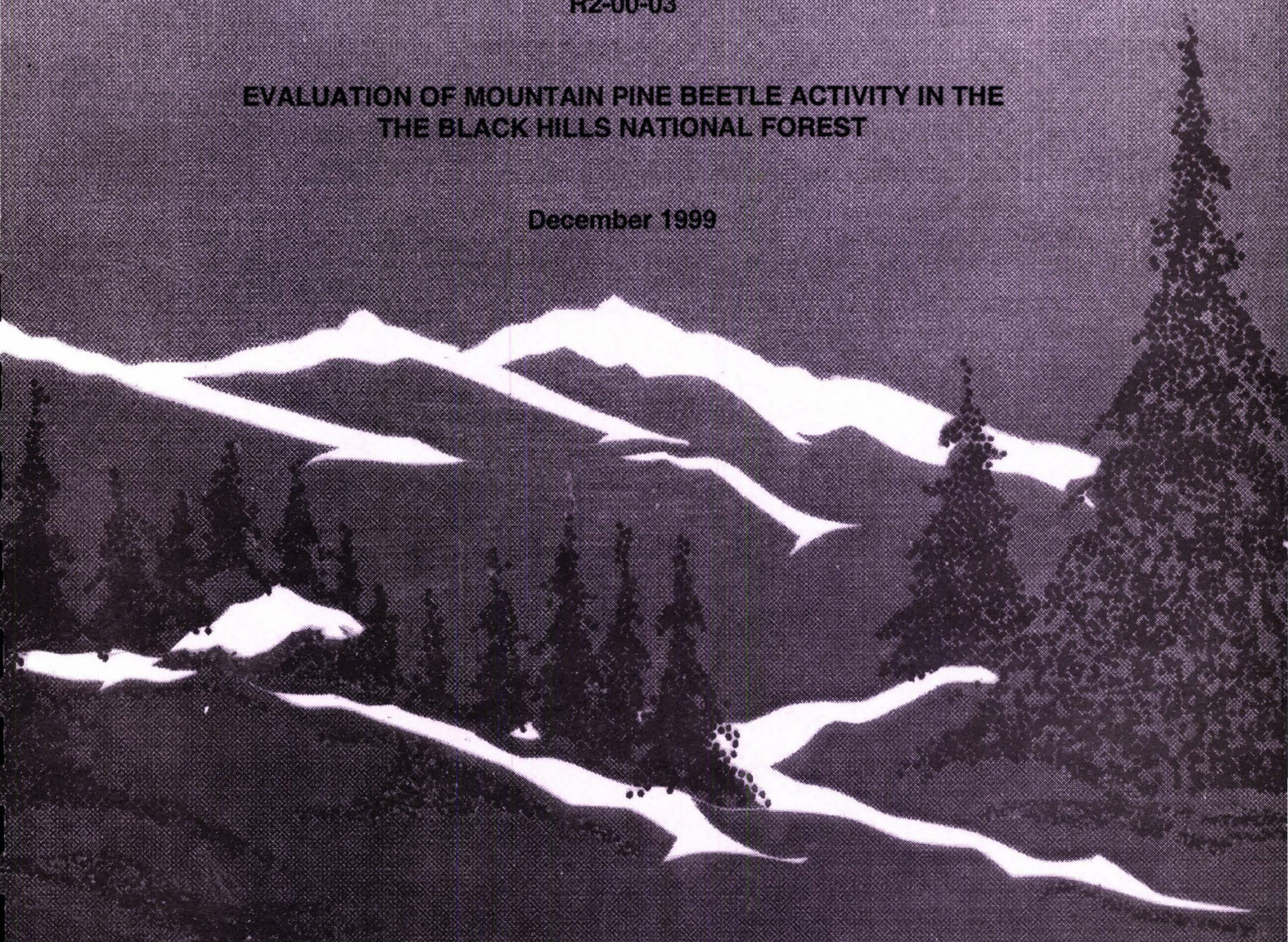
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# Forest Health Management

BIOLOGICAL EVALUATION  
R2-00-03

EVALUATION OF MOUNTAIN PINE BEETLE ACTIVITY IN THE  
THE BLACK HILLS NATIONAL FOREST

December 1999



United States  
Department of  
Agriculture

Renewable Resources  
Forest Health Management

Forest Service  
Rocky Mountain Region  
Denver, Colorado



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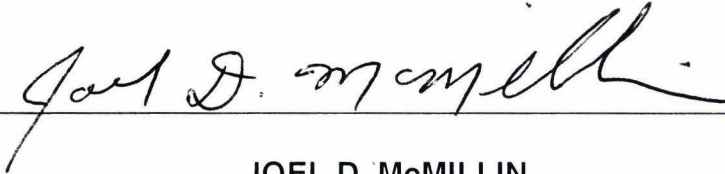
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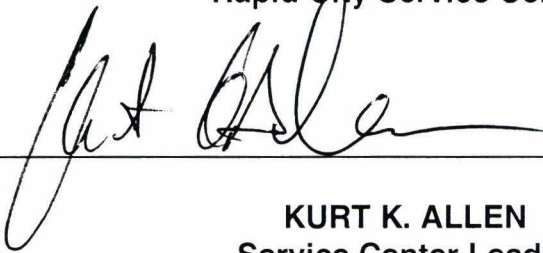
December 1999

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## ABSTRACT

Mountain pine beetle populations have been increasing on the Black Hills National Forest, South Dakota and Wyoming, beginning in 1996. The 1999 aerial survey detected mountain pine beetle infestations in several areas of the Black Hills. Some of the areas having infestations were near Blackhawk, Steamboat Rock, Pactola Lake, Spearfish Canyon, Bear Mountain, and Silver City. Ground surveys were conducted in these areas to assess the level of current infestation and to compare the rates of increase in tree mortality over a three-year period. Based on the ground surveys, beetle-caused mortality seems to be static or is declining throughout most of the Blackhawk and Steamboat Rock areas, Spearfish Canyon, around Pactola Lake and Silver City, and Mt. Rushmore National Memorial. Increasing mortality was found in the Bear Mountain and Deerfield Lake areas. Strategies for dealing with the mountain pine beetle include: do nothing, silvicultural treatments, sanitation/salvage harvesting, infested tree treatment and individual tree protection. Recommendations for the evaluated areas include a combination of treatments depending on site objective and suitability.

In addition to these forested areas, campgrounds and day use areas at the Sheridan and Pactola Lake recreation areas were surveyed for bark beetle activity. Sanitation removal of infested trees was completed in the campgrounds of the recreation areas during 1998 and 1999. Ground surveys found a relative decrease in the number of infested green trees; however, small pockets of mortality were still observed. In addition to the recommendation for continued sanitation treatments, a limited number of high value trees may be chemically protected. Long-term silvicultural treatments of areas adjacent to the campgrounds would enhance the protection of trees in the campgrounds.

## INTRODUCTION

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins) is the number one insect killer of pines throughout the western United States. The beetle is a native to North America and attacks most pine species in the West, including ponderosa pine in the Black Hills of South Dakota and Wyoming.

The mountain pine beetle has one generation per year in the Black Hills. Adult flight typically occurs between July and August, when adults leave previously infested trees and attack uninfested, green trees (i.e., trees having needles that are still green). The adults chew through the bark of green trees and construct galleries along which eggs are laid. Larvae emerge from the eggs and begin feeding on the phloem of the tree in late summer to early fall. Larvae, pupae, or callow adults can overwinter under the bark of the infested tree. In the spring, the beetle finishes its maturation process, producing the next generation of adults.

Populations of the mountain pine beetle are usually found at an endemic level, killing and reproducing in stressed or weakened trees, including trees struck by lightning and affected by root disease. Mortality of less than one tree per acre per year is considered to be an endemic level. For reasons that are not fully understood, beetle populations can increase dramatically over a few years. The beetles go through an increasing stage (more than 1 tree per acre per year killed, but less than 10% of the stand affected over a 3-year period) and finally into an epidemic stage where 10% or more of the stand is affected in a 3-year period (Lessard 1982). In the increasing and epidemic stages, healthy trees are attacked and killed in addition to stressed trees.

The beetle is native to the Black Hills forest ecosystem, with outbreaks occurring periodically. The first recorded outbreak in the Black Hills occurred from the late 1890's through the early 1900's and killed an estimated 1-2 billion board feet of timber. Outbreaks also have occurred in the 1930's, 1940's, 1960's and 1970's, each lasting 8-13 years with the 1970's outbreak being larger and causing more mortality than any of the others (Thompson 1975). The most recent outbreak occurred from 1988-1992 in the Bearhouse Area on the Harney Ranger District and ended up killing over 50,000 trees (Pasek and Schaupp 1992). Outbreaks of the beetle can cause considerable changes in forested stands, including a reduction in average stand diameter and stand density (McCambridge et al. 1982). Mortality levels of 25% can be expected throughout the landscape surrounding outbreak areas and levels of up to 50% can occur in heavily attacked stands (McCambridge et al. 1982). The levels of mortality caused in an epidemic and the associated change in stand structure and composition can be detrimental to forest objectives: it reduces timber stocking levels, can affect wildlife habitat, can increase short term fire risks, and can negatively effect visual and recreation values.

Pine stands in the Black Hills can be categorized in their susceptibility to beetle attack. In general, stands are considered to be most susceptible when 75% of the stand is in the 7-13 inch diameter range and the stand density is over 120 feet of basal area per acre (Stevens et al. 1980, Schmid and Mata 1992). These general hazard rating guidelines, and most stand inventory data, are based on stand averages; small pockets that have high stocking levels within a stand of low density can be a focal point for beetle buildup. Stand hazard ratings give

an indication of which stands are most probable to have the initial beetle infestations. Once an outbreak has started, any stands containing suitable host material can incur damage. These ratings also give no indication of local beetle pressure. However, hazard ratings can help to prioritize what stands should be treated to minimize beetle susceptibility. They also point out that forest management strategies that decrease stocking densities is often the best approach to reduce long-term losses to the mountain pine beetle. Stands with low stocking densities will be less likely to have beetle outbreaks initiated in them, but it is a continual process to keep them lowered. Recent work has shown that stands that are treated to 60 basal area can be expected to reach high hazard (120 basal area) again in about 25-50 years. Stands treated to 80 basal area can reach 120 basal area in 13-36 years, and stands treated to only 100 basal area will be back to 120 basal area in 9-16 years (Obedzinski et al. 1999). These timeframes of when a forest can increase in hazard level are relatively short, often shorter than typical time intervals between stand re-entries.

Other forms of control of mountain pine beetle, such as natural enemies or environmentally related factors, are less predictable. Generally, when beetle populations reach outbreak proportions, natural enemies, such as birds and predaceous or parasitic insects, are not numerous enough to have a noticeable effect on the outbreak. Natural enemies are more important in limiting mountain pine beetle populations that are in the endemic phase (Bellows et al. 1998). Likewise, environmental factors cannot be counted on for lessening the outbreak. For instance, temperatures of  $-10^{\circ}$  F can kill beetles in October but temperatures of  $-25^{\circ}$  are needed by February (Schmid et al. 1993). These temperatures would need to be reached under the bark, in the phloem, as opposed to air temperatures. Beetles survive low temperatures by removing water from within their cells and replacing it with glycoproteins, which act as a type of anti-freeze (Bentz and Mullins 1999). This is a process known as cold hardening. Beetles can have supercooling points, the temperature at which ice crystals start to form in body tissues, as low as  $-32^{\circ}$  F in January (Bentz and Mullins 1999). Phloem temperatures become equal to air temperatures only when they persist for 24 hours or more (Schmid et al. 1993). In general, phloem temperatures are 5 to  $10^{\circ}$  warmer than air temperature.

Aerial surveys of the Black Hills are conducted annually at the end of summer. These surveys are used to detect pines that have been killed in the last 1-2 years and whose crowns have faded from green to reddish-orange. During the mid-1990's, beetle mortality was very light and scattered throughout the Hills. However, the 1997 aerial survey detected a noticeable increase of trees that had been attacked in 1996. The 1998 and 1999 surveys showed additional sharp increases with much of the heaviest damage concentrated into a few areas. Infestations were recorded in Beaver Park, areas west of the Blackhawk, Steamboat Rock, Silver City, Deerfield Lake, and Bear Mountain. The Beaver Park area was assessed in a separate biological evaluation (Allen and McMillin 1999). Sanitation and commercial harvesting was completed in the Steamboat Rock area in 1998 and is ongoing in the area west of Blackhawk. The campgrounds surrounding Sheridan and Pactola Lakes also represent areas that have an ongoing history of bark beetle problems.

The focus of this evaluation is to examine the level of bark beetle activity and stand conditions in these areas, determine what management alternatives should be implemented, and assess the effectiveness of sanitation treatments that have been carried out in some of these areas.

## **METHODS AND SITE DESCRIPTIONS**

### **Methods**

The level of mountain pine beetle activity on national forest and other federal lands was estimated using two methods: Aerial survey data and transect surveys to estimate the number of green, infested trees and the ratio of green attacked trees to attacks occurring in previous years. The aerial survey was conducted in late August 1999. The number of fading trees and their approximate location were mapped. This survey detected pines that were killed in the last 1-2 years and whose crowns have faded (e.g., trees killed in 1998 that faded in 1999). Currently infested trees, whose crowns have not faded, cannot be discerned from the air.

Transect surveys were conducted throughout all areas in October and November 1999. Transects varied in length between 0.5 and 2 miles and were approximately 1 chain wide, covering an area between 4 and 16 acres per transect. Within each transect, recently attacked trees were tallied. Attacked trees were broken into four categories: New beetle attacks (trees attacked in 1999), 1-year-old attacks (1998), 2-year-old attacks (1997), current pitchouts (attacked trees that probably will survive).

### **Site Descriptions**

#### ***Blackhawk***

The area of evaluation included federal lands delimited by Forest Service roads 126, 148, 149, and 777. A total of 10 transects were completed, covering 10 miles (80 acres) throughout this area. Only areas that were not harvested by 21 October 1999 were evaluated. Some of the areas traversed in transects were marked for harvest and will likely be cut in the near future. Further site description was provided in last year's biological evaluation (McMillin and Allen 1998).

#### ***Spearfish Canyon***

Based on the aerial survey and personal observations, the majority of beetle activity in Spearfish Canyon was occurring between the Long Valley and Botany Bay picnic grounds. Therefore, ground surveys were limited to this region of Spearfish Canyon. Three transects totaling 1.25 miles (10 acres) were completed. Areas surveyed included approximately 3.7 miles on the Spearfish Canyon Scenic Byway, 8.6 miles on the scenic byway, and near the Long Valley Picnic Ground.

#### ***Steamboat Rock***

The area around Steamboat Rock was evaluated through ground surveys in 1997 and 1998 (Allen 1998, Allen and McMillin 1998). As a result of the beetle situation, and because there was a planned timber sale in the area, the district re-evaluated the sale area changing volumes

to be removed in a sanitation effort. Cutting and removal of infested trees was completed in June of 1998. This year's assessment covered much of the same ground as reported in Allen and McMillin (1998), with additional stands evaluated to the west of Erskine Gulch. A total of 16 transects were completed, covering 16.25 miles (130 acres) throughout this area.

#### ***Silver City, Pactola Lake & Sheridan Lake areas***

For the Sheridan and Pactola Lake Recreation Areas, small pockets of beetle-caused tree mortality were noted in or very near each campground from the 1999 aerial survey. Ground surveys of campgrounds, day use, and surrounding areas were conducted in November of 1999 to determine the level of current beetle activity. Each campsite was visited along with about 60 feet into the forest surrounding each campground. Pockets of recently killed (1- and 2-year-old dead trees) and green, beetle infested trees were recorded. Also, unsuccessful attacks, or pitchouts, were noted. In addition, a larger, ongoing area of beetle activity was located near Pactola Lake, in stands around Silver City, and along Clear Creek. A total of 6 transects were completed, covering 4.75 miles (38 acres) throughout these areas.

#### ***Deerfield Lake area***

A total of 8 transects were completed, covering 6.25 miles (50 acres) throughout this area. These transects were adjacent to the Dutchman Campground, Deerfield Cove, Whitetail Campground, Mountain City, Hilltop Trailhead, and northeast of FS297 and FS17 junction.

#### ***Bear Mountain area***

The 1999 aerial survey detected numerous small pockets of tree mortality to the south and west of Bear Mountain. A total of 5 transects were completed, covering 6 miles (48 acres) throughout this area. The assessment included areas adjacent to FS293 (Sourdough Draw) and FS469.1G.

#### ***Mt. Rushmore National Memorial***

Forest Health Management was requested to provide assistance to Mt. Rushmore National Memorial personnel in surveying the memorial's land for mountain pine beetle activity. Two transects were completed in this area in October 1999, one to the east of the visitors center and one on the south side of Highway 244.

## **RESULTS**

#### ***Black Hills National Forest***

During the mid-1990's, beetle mortality was light and scattered throughout the Black Hills. In 1997, there was a noticeable increase in mortality detected. The 1999 survey showed another sharp increase from 1998, with much of the heaviest damage concentrated into a few areas. The aerial survey from 1999 detected a total of 25,562 trees killed throughout the Black Hills. This is an increase from the 10,726 trees killed on National Forest lands in 1998. Much of the damage was concentrated in groups of 25 trees or more in a few areas. Several additional areas of beetle activity were observed in the 1999 aerial survey, but were not ground checked. Some of these areas included Lemming Draw, Boles Canyon, near Pringle and Jewel Cave.

### **Blackhawk**

The ground surveys provided information on the current levels of beetle infestation, average tree diameter, and basal area (Table 1). Mortality from 1997, 1998, and green-infested trees show that there were about 2.2 trees killed per acre throughout the area. Beetle populations, based on the number of dead trees, remained relatively static, with slightly more trees currently infested than were attacked last year. Overall, there was a decrease in the number of killed trees compared with what was recorded in last year's biological evaluation (McMillin and Allen 1998).

Table 1 also lists the number of attacks, the average basal area, and diameter of trees by transect. The area having the largest concentration of beetles was along FS 148.1 in section 34 (transect 4). The average diameter at breast height ranged from 8 inches to 15 inches, providing suitably sized material for beetle infestation. The average basal area ranged from 110 to 170, with most being approximately 150 square feet per acre. Therefore, most of the area was characterized as being high beetle hazard. However, several of these areas will have substantially lowered basal area and average tree diameter upon completion of the active timber sale.

Table 1. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect near Blackhawk, SD.

| TREES KILLED PER ACRE |            |            |            |            |            |          |              |             |
|-----------------------|------------|------------|------------|------------|------------|----------|--------------|-------------|
| Line                  | 1999       | 1998       | 1997       | Pitch Out  | Total      | Acres    | BA           | DBH         |
| 1                     | 1.1        | 0.8        | 1.3        | 1.1        | 3.3        | 10       | 128          | 9.2         |
| 2                     | 0.5        | 0.9        | 0.3        | 0.5        | 2.1        | 8        | 175          | 10.1        |
| 3                     | 0.9        | 2.5        | 1.1        | 0.0        | 4.5        | 8        | 135          | 9.8         |
| 4                     | 2.0        | 0.4        | 0.3        | 0.0        | 2.6        | 8        | 155          | 11.8        |
| 5                     | 0.4        | 0.1        | 0.0        | 0.4        | 0.9        | 8        | 152.5        | 10.1        |
| 6                     | 1.0        | 0.0        | 0.0        | 0.0        | 1.0        | 8        | 110          | 12.2        |
| 7                     | 1.4        | 1.5        | 0.4        | 0.8        | 4.0        | 8        | 152.5        | 8.7         |
| 8                     | 1.9        | 0.4        | 0.3        | 0.0        | 2.7        | 12       | 135          | 10.1        |
| 9                     | 0.2        | 0.5        | 0.0        | 0.0        | 0.7        | 6        | 133.3        | 15.3        |
| 10                    | 0.5        | 0.0        | 0.0        | 0.0        | 0.5        | 4        | 155          | 10.8        |
| <b>Mean</b>           | <b>1.0</b> | <b>0.7</b> | <b>0.4</b> | <b>0.3</b> | <b>2.2</b> | <b>8</b> | <b>143.1</b> | <b>10.8</b> |

### ***Spearfish Canyon***

Based on the three transects in Spearfish Canyon, there was more tree mortality that occurred in 1998 than 1999 (Table 2). This suggests that there is a decreasing population within this area. In addition, although the average tree diameter was relatively high, basal area was comparatively low and overall stands averaged within the moderate hazard rating category.

Table 2. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect in Spearfish Canyon, SD.

| Line | TREES KILLED PER ACRE |      |      |           |       | Acres | BA    | DBH  |
|------|-----------------------|------|------|-----------|-------|-------|-------|------|
|      | 1999                  | 1998 | 1997 | Pitch Out | Total |       |       |      |
| 1    | 1.3                   | 2.0  | 0.5  | 0.8       | 4.5   | 4     | 130   | 8.7  |
| 2    | 2.3                   | 4.3  | 0.5  | 0.5       | 7.5   | 4     | 80    | 14.3 |
| 3    | 2.0                   | 5.0  | 0.5  | 0.0       | 7.5   | 2     | 100   | 13.9 |
| Mean | 1.8                   | 3.8  | 0.5  | 0.4       | 6.5   | 3.3   | 103.3 | 12.3 |

### ***Bear Mountain area***

Although the overall total tree mortality was relatively low, there was an increase in the number of trees killed per acre each of the last three years in the Bear Mountain area (Table 3). Of particular concern are the areas along spurs 1A and 2A of FS293 (transects 1 – 3). In addition, based on the average stand basal area and tree diameter, most of the area is dominated by high hazard stands.

Table 3. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect near Bear Mountain, Black Hills National Forest.

| Line | TREES KILLED PER ACRE |      |      |           |       | Acres | BA    | DBH  |
|------|-----------------------|------|------|-----------|-------|-------|-------|------|
|      | 1999                  | 1998 | 1997 | Pitch Out | Total |       |       |      |
| 1    | 3.6                   | 1.4  | 0.3  | 0.0       | 5.3   | 12    | 140   | 10.2 |
| 2    | 2.4                   | 1.3  | 0.0  | 0.0       | 3.6   | 8     | 132.5 | 11   |
| 3    | 3.0                   | 1.3  | 0.1  | 0.0       | 4.4   | 16    | 173.8 | 9.3  |
| 4    | 1.1                   | 2.0  | 0.4  | 0.0       | 3.5   | 8     | 152.5 | 10.4 |
| 5    | 0.0                   | 0.0  | 0.0  | 0.0       | 0.0   | 4     | 100   | 9    |
| Mean | 2.0                   | 1.2  | 0.2  | 0.0       | 3.4   | 9.6   | 139.8 | 10.0 |

### ***Steamboat Rock***

The 1999 ground surveys within the Steamboat Rock area found both fewer currently infested trees and a lower total number of trees killed than were reported in last year's biological evaluation (Allen and McMillin 1998) (Table 4). However, there was a noticeable increase in currently infested trees along FS144.1A (transects 11 and 14). There were more than five times as many currently infested trees as trees attacked in 1998. Stands in this area also had high basal area. Although there was a large number of trees killed in transect 5 (between FS145 and FS149), there seems to be a declining beetle population and beetle-caused mortality has decreased basal area.

Table 4. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect near Steamboat Rock area, Black Hills National Forest.

| Line        | TREES KILLED PER ACRE |            |            |            |            | Acres      | BA           | DBH         |
|-------------|-----------------------|------------|------------|------------|------------|------------|--------------|-------------|
|             | 1999                  | 1998       | 1997       | Pitch Out  | Total      |            |              |             |
| 1           | 0.9                   | 4.3        | 1.1        | 0.2        | 6.5        | 10         | 110          | 11.6        |
| 2           | 2.8                   | 2.5        | 2.2        | 0.2        | 7.7        | 6          | 100          | 9.9         |
| 3           | 1.1                   | 3.7        | 0.9        | 0.5        | 6.2        | 10         | 136          | 9.5         |
| 4           | 2.7                   | 1.5        | 1.0        | 0.3        | 5.5        | 6          | 157          | 9.5         |
| 5           | 7.3                   | 9.5        | 1.4        | 1.0        | 19.2       | 10         | 118          | 12.1        |
| 6           | 0.6                   | 0.8        | 0.6        | 0.1        | 2.1        | 8          | 148          | 11.6        |
| 7           | 0.3                   | 1.0        | 0.3        | 0.0        | 1.5        | 8          | 125          | 11.5        |
| 8           | 0.5                   | 0.1        | 0.0        | 0.0        | 0.6        | 8          | 110          | 10.2        |
| 9           | 0.6                   | 0.9        | 0.5        | 0.1        | 2.1        | 10         | 114          | 10.3        |
| 10          | 0.4                   | 1.1        | 0.4        | 0.1        | 2.0        | 8          | 110          | 11.7        |
| 11          | 2.8                   | 0.1        | 1.1        | 0.8        | 4.8        | 8          | 123          | 10.6        |
| 12          | 0.8                   | 0.3        | 0.2        | 0.0        | 1.3        | 6          | 127          | 13.2        |
| 13          | 1.8                   | 2.3        | 0.8        | 0.4        | 5.2        | 8          | 128          | 12.7        |
| 14          | 2.4                   | 0.5        | 0.0        | 0.0        | 2.9        | 8          | 145          | 11.3        |
| 15          | 0.6                   | 1.4        | 0.3        | 0.0        | 2.3        | 8          | 120          | 10.6        |
| 16          | 1.9                   | 2.0        | 2.3        | 0.0        | 6.2        | 8          | 128          | 11.1        |
| <b>Mean</b> | <b>1.7</b>            | <b>2.0</b> | <b>0.8</b> | <b>0.2</b> | <b>4.8</b> | <b>8.1</b> | <b>124.9</b> | <b>11.1</b> |

### ***Silver City, Pactola Lake & Sheridan Lake areas***

Ground surveys in the Pactola Lake and Silver City area found relatively few current infested trees and a low total number of killed trees (Table 5). Overall, there seems to be a static beetle population. Although the average stand basal falls within the moderate hazard rating category, there are many stands west of Silver City that contain high basal areas that could provide suitable habitat for future population build up.

Table 5. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect near Pactola Lake and Silver City, SD.

| Line        | TREES KILLED PER ACRE |            |            |            |            | Acres      | BA           | DBH         |
|-------------|-----------------------|------------|------------|------------|------------|------------|--------------|-------------|
|             | 1999                  | 1998       | 1997       | Pitch Out  | Total      |            |              |             |
| 1           | 1.3                   | 0.9        | 2.4        | 0.5        | 5.0        | 8          | 132.5        | 9.4         |
| 2           | 0.9                   | 0.8        | 0.0        | 0.1        | 1.8        | 8          | 107.5        | 10.4        |
| 3           | 1.2                   | 0.0        | 0.0        | 0.0        | 1.2        | 6          | 133.3        | 10.9        |
| 4           | 1.2                   | 0.3        | 1.0        | 0.0        | 2.5        | 6          | 83.3         | 9.1         |
| 5           | 1.5                   | 3.0        | 0.5        | 0.0        | 5.0        | 2          | 120          | 12.8        |
| 6           | 0.6                   | 1.9        | 0.5        | 0.1        | 3.1        | 8          | 100          | 10.8        |
| <b>Mean</b> | <b>1.1</b>            | <b>1.1</b> | <b>0.7</b> | <b>0.1</b> | <b>3.1</b> | <b>6.3</b> | <b>112.8</b> | <b>10.6</b> |

In the Pactola Reservoir Recreation Area, a total of 11 beetle-attacked trees were detected, including: 10 green, infested trees and 1 pitchout. The approximate locations of these attacks are listed in Table 6. Pitchouts are trees that have been unsuccessfully attacked by the beetles and will not die from the attack. However, these trees are often more susceptible to future attack and may be considered for removal. Small pockets of green infested and dead trees were found in transects behind the Pactola Pines store and the Pactola Campground (Table 5, transects 2 and 4). The pockets of green infested trees should receive attention at the same time sanitation practices are implemented in the campground areas. In addition to these attacks, there were pockets of green and dead trees outside the Jenny Gulch Picnic Ground that may provide an influx of beetles into the picnic area in the future.

In the Sheridan Lake Recreation Area, a total of 15 beetle-attacked trees were found, including: 14 green, infested trees and 1 pitchout. The approximate locations of these attacks are listed in Table 6. Pockets of mortality were not observed in the forest immediately adjacent to the campground areas; however, small pockets of mortality were recorded within a quarter mile in the 1999 aerial survey.

Table 6. Number of trees attacked by mountain pine beetle according attacked in 1999 and location of attack in the Sheridan and Pactola Lake campgrounds, Black Hills National Forest.

| Location                                    | Number of trees attacked |           |
|---------------------------------------------|--------------------------|-----------|
|                                             | 1999                     | Pitchouts |
| <u>Sheridan Lake Recreation Area</u>        |                          |           |
| Site 127 (Rocky Loop)                       | 1                        | 0         |
| Site 110 (Rocky Loop)                       | 1                        | 1         |
| Site 106 (Thumper Loop)                     | 1                        | 0         |
| Site 82 (Chipper Loop)                      | 1                        | 0         |
| Site 47 by lake (Woodsey Loop)              | 1                        | 0         |
| Site 34 (Smokey Loop)                       | 2                        | 0         |
| Site 35 (Smokey Loop)                       | 1                        | 0         |
| South Beach Picnic Ground                   | 4                        | 0         |
| Susie Squirrel Group Campground             | 1                        | 0         |
| Ranger Rick Group Campground                | 1                        | 0         |
| <u>Pactola Reservoir Recreation Area</u>    |                          |           |
| <u>Pactola Lake Campground</u>              |                          |           |
| Rest rooms between Sites 76 and 73 (Loop B) | 2                        | 0         |
| Site 79 (Loop B)                            | 1                        | 1         |
| <u>Bear Gulch Campground</u>                |                          |           |
| Site 8                                      | 5                        | 0         |
| <u>Jenny Gulch Picnic Ground</u>            |                          |           |
| North side of road                          | 2                        | 0         |

### ***Deerfield Lake area***

Although there were relatively few trees killed per acre over the last three years, there was a slight increase in current infested trees compared with trees killed in 1998. The area near the Mountain City boat ramp (transect 6) contained currently infested trees and therefore may be an area of concern. There was a wide range of basal area over the areas assessed, but overall stand basal fell within the moderate hazard rating category.

Table 7. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect near Deerfield Lake, Black Hills National Forest.

| Line | TREES KILLED PER ACRE |      |      |           |       | Acres | BA    | DBH  |
|------|-----------------------|------|------|-----------|-------|-------|-------|------|
|      | 1999                  | 1998 | 1997 | Pitch Out | Total |       |       |      |
| 1    | 0.3                   | 0.5  | 0.0  | 0.0       | 0.8   | 4     | 145   | 10.6 |
| 2    | 3.0                   | 3.0  | 0.0  | 0.0       | 6.0   | 4     | 130   | 12.4 |
| 3    | 0.8                   | 0.3  | 0.3  | 0.0       | 1.3   | 4     | 100   | 12.5 |
| 4    | 0.8                   | 1.3  | 0.0  | 0.0       | 2.0   | 4     | na    | na   |
| 5    | 0.1                   | 0.2  | 0.0  | 0.0       | 0.3   | 10    | 92    | 14.2 |
| 6    | 4.0                   | 0.0  | 0.0  | 0.0       | 4.0   | 2     | 100   | 11.9 |
| 7    | 0.3                   | 0.0  | 0.0  | 0.0       | 0.3   | 16    | 117.5 | 9.6  |
| 8    | 0.0                   | 0.0  | 0.0  | 0.0       | 0.0   | 6     | 83.3  | 9.8  |
| Mean | 1.1                   | 0.7  | 0.1  | 0.0       | 1.8   | 6.3   | 109.7 | 11.6 |

### ***Mt. Rushmore National Memorial***

The two transects within the Mt. Rushmore National Memorial found little evidence of current beetle activity. However, several of the stands that were surveyed had moderate to high basal areas and large tree diameters.

Table 8. Number of trees attacked per acre by mountain pine beetle, basal area (BA), and average tree diameter (DBH), by transect near Mt. Rushmore National Memorial, SD.

| Line | TREES KILLED PER ACRE |      |      |           |       | Acres | BA  | DBH  |
|------|-----------------------|------|------|-----------|-------|-------|-----|------|
|      | 1999                  | 1998 | 1997 | Pitch Out | Total |       |     |      |
| 1    | 0.0                   | 0.0  | 0.2  | 0.3       | 0.5   | 6     | 107 | 15.6 |
| 2    | 0.2                   | 0.8  | 0.5  | 0.0       | 1.3   | 6     | 127 | 12.4 |
| Mean | 0.1                   | 0.4  | 0.4  | 0.2       | 0.9   | 6     | 117 | 14.0 |

## CONCLUSIONS

Based on the aerial surveys for the last three years, mountain pine beetle populations and consequent tree mortality are increasing throughout the Black Hills. The number of trees attacked and the buildup ratios for the areas surveyed are typical for the Black Hills. The number of trees per acre attacked in one year has been as high as 26.8, on the Spearfish District in the beetle epidemic of the 1970's (Creasap and Minnemeyer 1976) and 61.4 and 41.6 in the Bearhouse area in the early 1990's (Pasek and Schaupp 1992). Year-to-year attack ratios of 1 tree killed in the previous year to 2 or more trees killed in the current year are fairly common during population buildups.

In the Blackhawk area, mountain pine beetle activity last year was considered to be in the increasing phase or approaching the epidemic phase (McMillin and Allen 1998). There were spots where almost every tree had been killed and many of the spots had green infested trees that produced beetles in the summer of 1999. However, relatively few and small pockets of mortality were found this year. Therefore, it seems that current sanitation efforts in combination with the timber sale are working to reduce the threat of additional tree mortality. Nevertheless, the use of sanitation harvests to help lessen the impact of beetles may take 2 or 3 more years before most of the activity is stopped. Stands that were not included within the sale may act as focal points for future beetle infestations.

Similar to the Blackhawk area, sanitation and thinning efforts seem to be causing a decrease in beetle activity within the Steamboat Rock area. However, stands along FS144.1A have an increasing beetle population and have basal areas that will provide suitable habitat for continued beetle increase.

Forested lands within Spearfish Canyon and Mt. Rushmore National Memorial do not appear to have high beetle activity at this time. The beetle populations were declining throughout these two areas. This does not mean that tree mortality will not occur, but that mortality should be limited small pockets of 1-2 trees and less than 2 trees per acre over the next few years.

Bear Mountain and the Deerfield Lake areas have increasing beetle populations and associated tree mortality. Many of these areas have stands containing high basal areas and should be categorized as having a high hazard rating. Close attention should be paid to these areas over the next few years.

Bark beetles likely will continue to kill pockets of trees within the campgrounds and surrounding areas at Sheridan and Pactola Lakes. However, the sanitation work accomplished for the Pactola Lake campgrounds in 1999 probably contributed to the slight decrease in the number of newly infested trees. The number of green attacked trees in 1999 (14) in the Sheridan Lake Campground was similar to the previous year (15). Most of the currently infested trees are probably a result of beetles migrating from the forest outside the recreation sites. How much damage will be sustained within the campgrounds in coming years is difficult to estimate, but without treating infested trees, the problem will persist and probably grow. In addition to managing the campgrounds, Forest Service land adjacent to the

campgrounds should be addressed as part of the overall plan. For example, pockets of infestation near Silver City will provide beetles to re-infest Pactola Reservoir recreation sites.

As mentioned in the results section, additional areas of beetle-caused mortality were observed in the 1999 aerial survey, but were not ground checked. Stand conditions in many of these areas are conducive to sustaining high levels of beetle-caused mortality. Once beetle populations get started, the beetles can infest any surrounding stands that have suitable diameter material.

## ALTERNATIVES

There are a number of actions that can be used to reduce the impacts of mountain pine beetle in the areas evaluated. Actions are comprised of either direct action against the beetles themselves or indirect action that focuses on general stand conditions. Direct action deals with the symptoms (e.g., too many beetles in one place at one time), and is aimed at directly reducing the number of beetles present. Indirect action concentrates on the cause of the problem. For example, stand conditions that are adequate for beetle buildup and sustaining high populations (e.g., dense stands comprised of medium to large diameter trees).

The only effective long-term strategy to minimize beetle-caused mortality is controlling stand conditions silviculturally over entire landscapes and constant monitoring for areas of beetle buildup.

**Alternative 1: Do Nothing.** Accept that beetle-caused tree mortality and the impacts associated with it as a natural process. The extent of the damage to the stands in these areas is difficult to estimate, but there will probably be significant changes in the forest caused by beetles.

Where to use: Use where other alternatives are not feasible or are inappropriate.

**Advantages:** There is no mechanical site disturbance. There will be an increase in the amount of light getting to the forest floor, so that understory species and regeneration may be enhanced. Habitat for some wildlife species may be enhanced due to decreasing crown closure and creation of standing dead trees.

**Disadvantages:** This alternative allows beetle populations to increase and spread to other trees and surrounding areas. There is a loss in timber revenues from either not harvesting beetle-killed trees or letting the infestation grow and increasing the amount of killed timber. Fire hazards can intensify with the increase in dead material, including red, dry needles. Visual and recreation values can be negatively affected. The loss of overstory tree cover can have a negative effect for some wildlife species. Regeneration can be impeded as dead trees fall and cover or shade the forest floor.

**Alternative 2: Silvicultural Treatment.** These are actions that increase tree vigor and reduce stand susceptibility to beetle attack. It is generally considered a preventative treatment that is implemented prior to stands experiencing beetle outbreaks. In the Black Hills, stands

that are less than 80 square feet of basal area per acre with average stand diameters of fewer than 7 inches are at the lowest risk. When treating stands care must be taken to avoid leaving pockets of dense trees in an otherwise thinned stand.

Where to use: This is a preventative tactic and should be used regularly when planning timber harvests.

Advantages: Silvicultural treatments can reduce overall stand susceptibility to beetle infestation. However, this treatment does not guarantee that beetle-caused mortality will be eliminated; it creates conditions that are less prone to experience a beetle outbreak. It maximizes the economic return from timber sales, as cutting is done prior to mortality taking place. Although the forest will experience mortality through time, treating stands silviculturally allows the decisions on what the forest will look like in the future through the types of harvesting implemented. If not, the beetles will decide what the forest will look like in the future through their actions, and this may be considerably different than forest objectives.

Disadvantages: This action is not suitable for areas where timber harvest is not feasible. Building of roads (if required) and cutting and removal of trees can create site disturbances.

**Alternative 3: Sanitation/Salvage Harvest.** Sanitation harvesting involves removing currently infested pines prior to the beetles maturing and leaving to infest new trees. It requires the removal of green trees that have live brood in them. These green trees are already dead; however, the foliage will not change color until the following summer. Trees removed in a sanitation harvest are treated prior to beetle emergence by either moving them to at least one mile from the nearest live host type or by processing them at the mill. Salvage harvest involves the removal of beetle-killed trees that do not have live beetles in them. These trees have already changed color, their needles are either red or gone.

A relatively new, and largely experimental, approach to the sanitation of bark beetles includes the use of semiochemicals (e.g., pheromones produced by the beetles for aggregation or anti-aggregation behavior). One method that is used in combination with traditional sanitation practices involves baiting trees with aggregation pheromones in concentrated areas or on a grid system just prior to the adult flight period. After the trees are infested, the trees **must** be removed and treated as stated above. A spillover effect (i.e., trees adjacent the baited trees are also attacked) is commonly experienced when using this technique, and these neighboring, infested trees also must be removed and processed.

Where to use: Stands susceptible to mountain pine beetle that are currently under attack and where it is desirable to reduce beetle populations and recover timber resource value. Also appropriate where beetle populations threaten currently uninfested nearby stands.

Advantages: Beetle populations can be reduced in localized areas and in individual stands by removing most of the currently infested trees. The use of baits concentrates and contains beetles within the current infestation boundaries. This can provide some protection to surrounding uninfested trees and stands by removing a large source of attacking beetles. Timber values are recovered that would otherwise be lost or degraded. Fuel loading and fire

hazard can be reduced by removal of much of the dead needles and timber. Regeneration can be enhanced through overstory removal and site disturbance.

**Disadvantages:** This alternative has a short implementation time. Areas must be marked, cut, and processed prior to beetle flight (July - early August). Sanitation will not be effective on a large scale. It is only effective at suppressing beetles at the stand level and, therefore, will not work on a landscape level or when there is a chance of beetles re-infesting the treated area. Site disturbance that accompanies timber harvest occurs.

**Alternative 4: Infested Tree Treatment.** Cut and individually treat infested trees prior to beetle emergence. The action should kill most or all of the beetles within the cut trees. Examples of treatments include: cut and burn on site, cut and bury at least 6 inches on site, cut and chip, cut and debark, or cut and treat with a chemical insecticide.

**Where to use:** This is most appropriate for treating small spots in areas where high value resources are nearby. It can be used in areas that are unroaded or too steep for conventional sanitation or salvage harvesting.

**Advantages:** Beetle populations can be reduced or eliminated from the treated area. This can provide some relief to surrounding uninfested stands and trees. The site disturbance is less than in conventional harvesting operations. Regeneration can be enhanced through the removal of overstory trees. Fire hazard can be reduced.

**Disadvantages:** The implementation time for this alternative is short. Treatments must be implemented after new infested trees are located and prior to beetle flight. This treatment only reduces beetle pressure in a small area, it is not effective on a landscape scale. This treatment does nothing to address stand conditions that led to beetle buildup in the first place.

**Alternative 5: Protection of High Value Trees.** Prior to beetle emergence in the summer, the stems of high value trees are treated with a registered insecticide.

**Where to use:** On trees around residential areas and in campgrounds. Trees must be of significantly high value and be under heavy beetle pressure to justify treatment costs.

**Advantages:** This action is very effective at protecting individual trees from becoming infested.

**Disadvantages:** Insecticide application does not effectively reduce beetle populations or address the cause of the outbreak. It does not guarantee protection and application must be thorough for it to be effective. Many people have concerns regarding environmental contamination when using pesticides. It is extremely expensive and is only appropriate for a single or a few high value trees.

## RECOMMENDATIONS

### ***Blackhawk***

In this area, we recommend a combination of alternatives 2 and 3. The active timber sale has removed many of the high density stands that contained large number of beetles. These areas should be relatively free of beetles and should prevent future losses to beetles. However, continued monitoring of mountain pine beetle populations in stands not included within the active timber sale is advised. Areas that were left for thermal cover units are composed of high density stands, making them targets for future beetle build up. Alternative 3, sanitation and salvage logging, may be needed in these areas to prevent movement of beetles from these areas to thinned stands.

### ***Spearfish Canyon***

Mountain pine beetle activity in Spearfish Canyon seems to be limited at this time to inaccessible areas where commercial harvesting would be difficult to accomplish. The use of non-commercial methods for treating infested trees on site may be feasible. This would include cutting and peeling of infested trees on site before the end of April to ensure that brood would not fully develop.

### ***Steamboat Rock***

The sanitation/salvage activities completed in 1998, in combination with commercial thinning, seem to have reduced beetle populations throughout much of this area. Continued sanitation should be done to reduce beetle populations further and protect the remaining stands. Areas of special concern include stands west of Erskine Gulch and along FS144.1A. The area west of Erskine Gulch contains many stands having high basal areas and a building population of beetles. A combination of alternatives 2 (thinning) and 3 (sanitation) would be appropriate in this area.

### ***Silver City, Pactola Lake & Sheridan Lake areas***

The continuation of sanitation/salvage practices is recommended in the campgrounds. Of particular importance is the sanitation of green infested trees. This will reduce the population of beetles in the campgrounds proper, thereby removing a local source of re-infestation. Removal of standing dead (salvage) could also be accomplished at this time, as a means of reducing potential future hazard trees in the campgrounds. Alternative 2, silvicultural treatments should be considered for the campgrounds and surrounding areas in the future. Alternative 5, protection of high value trees, should be considered for specific, high value trees. Surrounding areas that could be a source of beetles for re-infestation, such as the areas around Silver City, should be examined for possible treatment.

### ***Deerfield Lake area***

Similar to the Pactola and Sheridan Lake areas, annual monitoring of campgrounds, day use lands, and surrounding areas will be needed over the next few years in the face of beetle population increase throughout this portion of the Black Hills. A combination of alternatives 2, 3, 4, and 5 may be warranted depending on site and suitability.

### ***Bear Mountain area***

Alternatives 2 and 3 are recommended depending on the management focus of different stands. Beetle populations showed a sharp increase compared with last year and favorable stand conditions exist in this area. Therefore, there is the potential for significant tree mortality to occur in this area over the next few years.

### ***Mt. Rushmore National Memorial***

There does not seem to be much beetle activity on the areas of the memorial that were examined. This is not to say that beetle-caused mortality will not occur, but the potential for extensive tree mortality appears to be limited at this time. For the most part, current and previously infested trees were limited to small pockets of 2-3 trees. In addition, the sanitation actions that occurred late spring of 1999 probably helped to lessen the beetle population in this area. An annual monitoring of beetle activity in the area should be incorporated into the memorial's vegetation management plan.

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